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TECHNICAL REPORT
67-83-CM

METHODS FOR REMOVAL OF HARD-WATER SCALE
FROM U.S. ARMY KITCHEN EQUIPMENT

by

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March 1967

Series: CAOM-32

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FOREWORD

This study concerns removal of the hard-water scale that deposits on U.S. Army food-preparing and serving equipment where hot water or heating units are employed. The loss of efficiency of this equipment due to the deposit of hard-water scale will continue unless the recommendations of this report are given critical consideration.

A relatively simple system was developed for the removal of scale from the water compartments of coffee urns, steam tables and dishwashers. The same product and procedures can be used for the removal of scale from other heat transfer surfaces. The periodic use of the recommended scale-removing compound would reduce the cost of repairs, produce new-equipment performance of the referenced items, reduce stop-down time and, in the case of coffee urns, produce better coffee.

A copy of a draft of this report was forwarded to the U.S. Army Mobility Equipment Command and word was received that a Department of the Army Technical Bulletin based on it will be prepared which will establish the recommended procedures for scale removal from kitchen equipment.

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ABSTRACT

Hard-water scale is formed in nearly all food-preparing and serving kitchen equipment in which water is heated, and its removal is a major problem to the U. S. Army in hard water areas. As a result of this investigation, methods for the removal of hard-water scale in minutes or hours, depending on the quantity of deposits, were developed using a chemical scale-removing compound available from Government supply agencies. A product containing primarily sulfamic acid, a pH indicator, a corrosion inhibitor and an anticaking agent proved most economical and effective for this purpose. The cause of water hardness, the formation of hard-water scale, the properties of scale removers, and the recommended methods for the prevention and removal of scale from the various types of kitchen equipment are discussed.

METHODS FOR REMOVAL OF HARD-WATER SCALE

FROM U. S. ARMY KITCHEN EQUIPMENT

1. Introduction

Hard-water scale is a problem in the U. S. Army as it reduces the heating efficiency of food-preparing and serving equipment, reduces the capacity of containers (scale may occupy a substantial part of the water compartment of a coffee urn), and adversely affects the taste of coffee. Its removal would increase the efficiency of this equipment and reduce or eliminate major repairs now resulting from the accumulation of scale.

None of the manuals on the operation or preventive maintenance of Army kitchen equipment include methods of removing this deposit. Technical Manual TM 5-637, Inspection and Preventive Maintenance Services for Kitchen Equipment⁽¹⁾, establishes that the Post Engineer is responsible for scheduling regular inspection and preventive maintenance services, keeping up-to-date records of these services, and regularly checking the mechanical operation of all kitchen equipment. Under first echelon maintenance tasks, the manual refers to the removal of lime (scale) from the key or plug of the water faucet of a coffee urn, but it does not refer to the scale accumulation in the water compartment of the coffee urn nor does it suggest methods of removing the scale deposits. Of the Army installations visited, not one is practicing periodical removal of scale from the water compartment of coffee urns.

Technical Manual TM 5-636, Kitchen Equipment Repairs and Utilities⁽²⁾, does not even mention hard-water scale.

Chapter 1, paragraph 3, of Technical Manual TM 10-415⁽³⁾, Operation of Garrison Mess Equipment, states that "The manufacturer's manual for every item used must be available and must be studied and followed by operators and maintenance personnel. If the instructions presented here differ from those given in the manufacturer's manual or on the instruction plate attached to the equipment (Para. 4), the manufacturer's instructions will be followed." But there was nothing relative to scale removal on the instruction plates of the equipment observed at Ft. Devens, Mass. Paragraph 9a(2) of this manual (TM 10-415) says "Drain off water that has been left in the urn" but it does not warn that the drain of the water compartment must be kept free of solids to avoid greater problems.

Paragraph 31(f) of Technical Manual TM 10-405, Army Mess Operations⁽⁴⁾, establishes that it is the duty of the mess steward to "Check appliances and equipment frequently, report shortages, and recommend necessary repairs," which could be understood to include the proper operation of the drain lines of the water compartment of the coffee urn.

While methods for removing scale are not included in these manuals, removal is currently being attempted, although the methods, while sometimes effective, are slow, expensive, and obsolete. In equipment where the deposit is visible and accessible, scale is removed by scouring with an abrasive material or by treating with vinegar, lemon juice, orange juice, or a solution of a sour salt. When the deposit is hidden or inaccessible, it is not treated or removed until the equipment is dismantled.

During 1960 and 1961, the Quartermaster Corps Field Evaluation Agency (FEA) conducted limited field tests at Ft. Knox and Ft. Campbell, Kentucky to remove the scale from the water compartment of coffee urns. Sulfamic acid was used to dissolve the scale. A solution of methyl violet was used to determine the strength of the solution, and a solution of methyl red was used to determine whether or not the cleaned urn had been rinsed free of acid. The results of these tests are contained in Technical Report T-218, A Field Study of Cleaning Agent for Water Compartment of Military Type Coffee Urns⁽⁵⁾. Although the procedure was endorsed by the U. S. Army Natick Laboratories (NLABS) to The Quartermaster General⁽⁶⁾, the use of a scale-removing compound with external indicators was unfavorably considered for field use by the U. S. Army Mobility Equipment Center.

In 1964, the U. S. Army Subsistence Center (USASC), Chicago, Illinois requested that NLABS evaluate scale-removing compounds and develop methods for removing scale from the heat-transfer parts of coffee urns, steam tables, and dishwashers located at Army installations⁽⁷⁾. The U. S. Army Mobility Equipment Center, St. Louis, Missouri concurred⁽⁸⁾ with the test plan submitted by NLABS and stated that the data collected would be appropriate for incorporation into a Department of the Army Technical Bulletin and for an operational and maintenance manual on descaling procedures. It was requested that the investigation include the study of Scale-Removing Compound, Federal Specification P-S-170, FSN 6850-637-6142, which contains a pH color indicator.

2. Formation of Scale

The water used in Army mess operations contains dissolved salts in amounts depending on its source and treatment. These salts produce either carbonate (temporary) or non-carbonate (permanent) water hardness. Carbonate hardness is attributable to calcium or magnesium bicarbonates that may be removed with hydrated lime in accordance with the equation as follows:

$\text{Ca(OH)}_2 + \text{Ca(HCO}_3)_2 = 2 \text{CaCO}_3 + 2\text{H}_2\text{O}$, or removed simply by heating in accordance with the equation as follows:

$\text{Ca(HCO}_3)_2 + \text{heat} = \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2$. As illustrated in this equation, a soluble bicarbonate salt is decomposed and a precipitate is formed when heated. Non-carbonate hardness is caused by sulfates, chlorides, or other soluble non-carbonate salts that do not precipitate on heating and, therefore, must be removed by other means. The hardness of the tap water at Army installations varies from 3 to 706 parts per million, expressed as calcium carbonate.

The precipitate or scale that forms when hard water is heated is identified as hard-water scale. The amount of scale deposited on vessels is dependent on the carbonate hardness of the water. As stated previously, scale deposited on steam coils, heating elements, and the walls and bottom of hot water compartments decreases the rate of heat transfer and thus increases the time to boil water; restricts or blocks openings and thus interferes with the withdrawal of water through faucets; and forms a rough surface that promotes contamination. Loose scale may spall from the heating element or vessel interior and it also may obstruct drain outlets. This clogging makes it difficult to empty the water compartment and replenish it with fresh water to brew coffee.

3. Types of Scale-Removing Compounds

Although muriatic acid has wide application in commercial descaling operations, most acids in liquid form are not wholly acceptable for use with food preparation equipment because they are corrosive and, therefore, hazardous to handle. To reduce the effect of muriatic acid on metals, it is usually inhibited and is furnished in carboys at a concentration of 18°Be, or 28 percent HCl. Nevertheless, the handling of muriatic acid requires special training that is seldom given to Army mess personnel. The advantage is its low cost, but this is offset by the special care required for safe handling.

Approximately 11 quarts of vinegar, which contains about 5 percent acetic acid, will dissolve one pound of calcium carbonate scale. At 19¢ a quart, it would cost approximately \$2.10 to remove one pound of scale.

Lemon juice, which contains about 7 percent citric acid, reacts with scale to form calcium citrate, a compound that is not readily soluble in water. At 62¢ a quart, this would cost about \$2.55 per pound of scale removed.

Phosphoric acid has been recommended for the removal of scale, but it is not suitable because its reaction speed is too slow; it forms an insoluble precipitate, calcium phosphate, which is objectionable; and, like other liquids, it requires handling precautions and container disposal or accounting.

The most practicable method for the removal of hard-water scale is through the use of sulfamic acid, a powdered or crystalline chemical. As a solid, it is easy to handle and store, requires no special training to use and, with normal care, creates no hazard when handled in solution. Sulfamic acid, when formulated with a corrosion inhibitor, is highly effective in the removal of hard-water scale from metallic surfaces. The salts produced by its reaction with hard-water scale are readily soluble in water. Speed of reaction and optimum reaction temperature and concentration data were not known and, therefore, it was proposed to obtain these data in this study.

4. Laboratory Tests of Sulfamic Acid Mixtures

One highly effective sulfamic acid scale-removing compound, covered by FSN 6850-637-6142, is described in Federal Specification P-S-120. It is available in 100-pound drums at a cost of \$21.00. It is a mixture of 96 percent crystalline sulfamic acid of 99.6 percent purity; 0.1 percent metanil yellow dye; 1.0 percent 1, 3,-diethylthiourea (a corrosion inhibitor); and a 1.0 percent magnesium oxide (an anticaking agent). The indicating dye not only gives the dry acid a distinctive yellow color but, in solution, performs as pH indicator. This product was tested at NLABS and evaluated on kitchen equipment at Ft. Devens, Massachusetts, a soft-water area, and at Ft. Riley, Kansas, a hard-water area. It was found that, at 21¢ a pound, it would cost about 48¢ to remove one pound of scale.

To check the efficiency of sulfamic acid mixtures in dissolving hard-water scale, 100 pounds of the compound identified as FSN 6850-619-8610 were obtained from Federal Supply Service.

The product contained sulfamic acid 1,3-diethylthiourea, and magnesium oxide, but no pH indicating dye. Specification P-S-120 for Scale Removing Compound requires that it contain a pH indicating dye. About 0.1 percent metanil yellow was added to the product. It was determined in the MLABS tests that a stoichiometric quantity of this mixture did not completely dissolve pure calcium carbonate even at a temperature of 190°F. It was calculated that it requires 2.3 parts of scale remover to dissolve 1.0 part of calcium carbonate. However, when a 15 percent excess of the scale remover was used at between 160° and 190°F., complete dissolution was obtained in acid concentrations of 1 to 6 percent in 20 to 6 minutes, respectively.

As a check of the efficacy of the 15 percent excess of sulfamic acid mixture, a small sample of scale obtained from an urn at Ft. Campbell was dissolved in a 6 percent solution. After 25 minutes at between 160° and 190°F. all but 2 to 3 percent of the scale was dissolved. The residue was probably SiO_2 . (The scale found in the urns at Ft. Campbell is reported to be 90 percent CaCO_3 , 8 percent MgCO_3 , and 2 percent silicates.)

A simple test was developed for the quantitative determination of the sulfamic acid in a solution. Ten milliliters of the sulfamic acid solution were titrated with 1.03N NaOH (41.25 g/liter) until the color changed from red to the golden yellow end-point of the metanil yellow dye indicator. The volume in milliliters of NaOH required to produce this change equals the concentration of the sulfamic acid solution.

A laboratory device was developed to remove the scale from the water compartment of a coffee urn. It consisted of a 5-gallon storage tank for the sulfamic acid solution, and a pump for circulating the solution from the tank to the coffee urn. A 5-gallon bucket placed on a hot plate was used to simulate the urn. The solution was siphoned from the bucket to the tank.

5. User Tests

Tests were performed at Ft. Devens, where the water hardness is 89 to 116 parts per million (ppm) expressed as calcium carbonate, and at Ft. Riley where the water hardness is 270 to 438 ppm.

A considerable amount of scale had accumulated in the water compartment of the coffee urns that were examined at both installations. At Ft. Riley, where the hardness of water is high, scale is deposited almost everywhere hot water is used, even in the drains of kitchen sinks. The referenced laboratory device was tried in the descaling of the water compartment of a coffee urn at Ft. Devens, but it did not lend itself to field practice. A less cumbersome means of descaling similar to that used during the 1960-1961 field tests⁽⁵⁾ proved to be more satisfactory. In this method, the cleanout hatch was not removed if the water compartment drain was open. Sufficient water was added to the water compartment so that the water could be heated and then withdrawn through the faucet. A slurry was made of Scale Remover Compound, Federal Specification P-S-120, FSN 6850-637-6142, with water withdrawn from the urn. The details are outlined in Method A of Appendix A.

When the drain is clogged, it is a good indication that a considerable amount of scale has accumulated. In this instance, it is necessary to remove the clean-out plugs, remove all loose scale and open the clogged drain with reamers or by dissolving the scale. Details for this type of cleaning are described in Method B of Appendix A.

A coffee urn descaled at Ft. Devens was inspected after six months of continuous service. The water compartment showed only a slight scale deposit (estimated to be about one-half pound). The water at Ft. Devens is relatively soft and in areas of equal hardness, scale could be controlled if the coffee urns are treated every three to six months in accordance with Method A of Appendix A.

As a result of the tests at Ft. Riley, it is estimated that it would require as much as 50 pounds of the compound to remove the scale that had accumulated in the water compartment of a coffee urn after it had been in use for about a year. If the drains are not kept open, those urns can fail to operate in less than that period of time. After a new or thoroughly descaled urn is put into service at Ft. Riley, it is estimated that the water compartment of a coffee urn can be kept free of scale, provided it is treated with 5 to 10 pounds of scale remover every two to three months.

The coils in the steam table and the water compartment of the bains-marie* require a daily to a weekly treatment with the scale

*A unit containing hot water for keeping foods warm.

remover, not only to remove the scale but also to maintain a clean appearance. Since the steam table is located in the serving line, the condition of the copper coils is an immediate indication of the cleanliness or lack of it in the mess hall.

A simple chore that can be performed by kitchen personnel for the removal of scale from the steam table and bains-marie is described in Appendix B.

At Ft. Riley, a large quantity of scale accumulated in some of the single-tank dishwashing machines. In one instance, the whole interior and part of the exterior surfaces of the dishwasher were coated with scale. A simple assignment that can be performed by the kitchen personnel to remove the scale from the dishwashing machines is described in Appendix C.

6. Special Problems Noted in User Tests

a. Coffee Urns

During the user tests, it was observed that the present coffee urns and their location have deficiencies that should be corrected, namely, in the location of the clean-out hatch, in the information on the instruction plate, and in the location of the steam coil. The clean-out hatch is located on the right side of the coffee urn. When the urns are placed close to each other, access to the cleanout plug of the left urn is blocked by the urn at the right. Consideration should be given to placing the cleanout hatch at the front of the urn under the faucets or instructing the Post Engineer to leave a space between urns for access to all cleanout plugs.

The wording on the instruction plate dealing with the cleaning of the urn should be made clear. As presently written, it is not apparent as to which part of the urn must be cleaned with trisodium phosphate.

When the clean-out plate is removed, access to the interior of the water compartment is sometimes obstructed by steam coils. This difficulty had been recognized earlier and was corrected as outlined in paragraph 3.10 of Specification MIL-U-11307B, Urns, Coffee, Steam, Gas or Electric Heated, with Stand, dated 13 June 1958. However, in paragraph 3.5.7 of Specification MIL-U-11307D, Urns, Coffee, Twin, Steam, Gas or Electric, with Stand, dated 9 April 1965, which supersedes

Specification MIL-U-11307B, there is no requirement to prevent the obstruction of the clean-out opening. Evidently the urns that were cleaned at Ft. Devens had been purchased either in accordance with Specification MIL-U-11307D or a Purchase Description, because the coils obstructed the opening of the clean-out plug.

The user tests also indicated that corrective action is required and the Post Engineer should be notified whenever the following malfunctions of the coffee urns are noted:

- (1) Water heats slowly. If it requires more than one hour to boil the water in the urn after the steam is turned on, scale may be insulating the heating surfaces.
- (2) Water drains slowly. If the water drains slowly or not at all from the faucet or drain pipe, scale may be plugging the opening.
- (3) Scale deposits on water faucet and sight glass.
- (4) Unusual noises occur when water is heated.

Whenever any of these conditions are observed, the scale should be dissolved in accordance with a method in Appendix A. Scale deposition in the water compartment is dependent on the carbonate hardness of the water and on how much the urn is used. Even under the most favorable conditions, however, the water compartment should be cleaned by Method A at least once every 6 months. If the drain line is clogged, the drain should be opened and the scale removed manually and chemically as outlined in Method B of Appendix A.

Scale can be completely removed from the water compartment of coffee urns by either of the two methods given; however, routine treatment in accordance with Method A will prevent the need for removing the clean-out hatch.

The scale-removing compound recommended is described in Federal Specification P-S-120 and is stocked under FSN 6850-637-6142. Used in the solution concentration recommended, it will have no serious adverse effect on the metal parts of the urn.

b. Bains-Marie, Steam Tables, and Dishwashers

Hard-water scale buildup in bains-marie and steam tables was found to be objectionable because the deposit decreased heat

transfer and presented an unsightly appearance. When the heat transfer parts are coated and the rate of heating is decreased, the primary purpose of this equipment is defeated; consequently, all surfaces should be free of scale. Both of these items should be descaled in accordance with the procedures outlined in Appendix B.

Hard-water scale in dishwashers, besides presenting an unsightly appearance, was found to adversely affect efficiency when the scale particles clog the spray nozzles. Periodic scale removal will prevent the nozzles from becoming clogged. The interior of the dishwasher should be periodically treated for the removal of scale as outlined in Appendix C.

7. Conclusion

The procedures developed for removing hard-water scale from certain pieces of kitchen equipment were found to be effective. They are described in detail in Appendixes A, B, and C. The referenced scale-removing compound is covered by Federal Specification P-S-120 and FSN 6850-637-6142.

8. Recommendations

Based on the information contained in this report, it is recommended that:

- a. A Department of the Army technical bulletin be prepared establishing procedures for scale removal from kitchen equipment.
- b. A training film be prepared or a team of individuals be trained for the subsequent indoctrination of Army mess personnel in scale-removal procedures.
- c. Clean-out plug, now at the side of the coffee urn, be placed in the front for easy access when urns are placed in a series.
- d. The instruction plate state that the water drain be kept free of scale and the Post Engineer be notified when it is clogged.

9. References

1. War Department Technical Manual, TM-637, Inspection and Preventive Maintenance Services for Kitchen Equipment, War Department, July 1945.
2. War Department Technical Manual, TM 5-636, Kitchen Equipment Repairs and Utilities, War Department, July 1946.
3. Department of the Army Technical Manual, TM 10-415, Operation of Garrison Mess Equipment, Headquarters, Department of the Army, January 1964.
4. Department of the Army Technical Manual, TM 10-405, Army Mess Operations, Headquarters, Department of the Army, September 1962.
5. Technical Report T-218, FEA 61026, A Field Study of Cleaning Agents for Water Compartment of Military Type Coffee Urns, Quartermaster Field Evaluation Agency, Ft. Lee, Virginia, dated February 1962.
6. Letter, Subject: FEA 61026, A Field Study of Cleaning Agents for Water Compartment of Military Type Coffee Urns from Headquarters, QM Research and Engineering Command, Natick, Mass. to The Quartermaster General, Washington, D.C. dated 14 June 1962.
7. Letter, Subject: Cleaning Dishwashers and Steam Tables, from U.S. Army Subsistence Center, Chicago, Illinois to Commanding General, U.S. Army Natick Laboratories, Natick, Mass., 11 June 1964.
8. 1st Indorsement, Subject, Scale Removal from Kitchen Equipment, from U.S. Army Mobility Equipment Center, St. Louis, Missouri to Commanding General, U.S. Army Natick Laboratories, Natick, Mass., dated 4 November 1964.

APPENDICES

- A. Recommended Procedures for the Removal of Hard-Water Scale from the Water Compartment of Coffee Urns
- B. Recommended Procedure for the Removal of Hard-Water Scale from Bains-Marie and Steam Tables
- C. Recommended Procedure for the Removal of Hard-Water Scale from Dishwashers

APPENDIX A

Recommended Procedure for the Removal of Hard-Water Scale from the Water Compartment of Coffee Urns by Field (second and third echelon) Maintenance Personnel - For the Routine Removal of Scale When Water Drain Line is not Clogged.

Method A (chemical treatment)

- a. Close cold-water supply valve and turn off heat source.
- b. Open water drain valve and empty the water compartment.
- c. Remove the condensate tube and vacuum relief valve.
Loosen top of water-level sight glass.
- d. Close water-drain valve, open cold-water supply valve, and turn on heat.
- e. Fill water compartment until water appears at bottom of sight glass.
- f. Add 5 cupfuls* of scale remover** to the water in the water compartment by mixing one cupful at a time of the scale remover in a pitcher of water that has been withdrawn from the water faucet and pouring this slurry slowly into the water compartment through the opening in the vacuum relief valve housing.
- g. Heat the solution in the water compartment to a temperature between 160°F and 190°F for 15 minutes, then check the color of the solution by withdrawing a sample from the water faucet.
- h. If the solution is yellow, turn off the heat, and add 5 more cupfuls of scale remover, repeating Steps f and g.
- i. If the solution is still yellow, after the third addition, turn off the heat, drain water compartment, and repeat Steps d through h. Repeat treatments d through h until color of solution remains pink-red after the 15-minute treatment.

* One cupful equals one pound of scale remover.

** Scale-Removing Compound, Federal Specification P-S-120, FSN 6850-637-6142.

APPENDIX A (Cont'd)

When the solution is pink-red, turn off the heat and drain solution from water compartment.

- j. Replace condensate tube and tighten top of sight glass. Wash out water compartment by closing water-drain valve, opening cold-water supply valve, and allowing the water to flow out through the condensate tube. Continue this overflow until the water does not taste sour.
- k. Drain water compartment, replace vacuum relief valve, close water-drain valve, and the urn is ready for use.

APPENDIX A (Cont'd)

Recommended Procedure for the Removal of Hard-Water Scale from the Water Compartment of Coffee Urns by Field (second and third echelon) Maintenance Personnel.

Method B (manual and chemical treatment)

(For removal of scale that has accumulated to such an extent that the water drain line is clogged.)

This procedure consists of manually removing loose scale from the water compartment and drain line and of chemically dissolving adherent scale that defies manual removal.

- a. Drain water compartment by opening faucet.
- b. Remove water-level sight glass and loosen the clean-out hatch cover.
- c. Remove clean-out hatch cover and gasket. Discard the gasket.
- d. Manually remove all loose scale. Open drain line with a stiff wire reamer or by dissolving the scale in the drain. It may be necessary to disconnect the drain pipe in order to unclog it. It also can be unclogged by placing several cupfuls of the scale remover into the water compartment over the drain pipe, fill to slightly below the lower level of the clean-out plug, then heat the solution. More compound is added when bubbling ceases or the solution turns yellow. Continue this treatment until drain is opened.
- e. Wash all loose scale down the drain.
- f. After the drain is open, install a new gasket and replace the hatch cover.
- g. Close water-drain valve, replace water sight glass (leaving the top connection loose), and remove condensate tube and vacuum relief valve.
- h. Open cold-water valve, turn on heat, and fill water compartment until water appears at bottom of sight glass.

APPENDIX A (Cont'd)

- i. Add five cupfuls of scale remover* to the water compartment by mixing one cupful at a time of the scale remover in a pitcher of water that has been withdrawn from the water faucet and pouring this slurry slowly into the water compartment through the vacuum relief valve housing opening.
- j. Heat the solution in the water compartment to a temperature between 160°F and 190°F for 15 minutes, then check the color of the solution by withdrawing a sample from the water faucet.
- k. If the solution is yellow, turn off the heat, and add 5 more cupfuls of scale remover, repeating Steps i and j.
- l. If the solution is still yellow, after the third addition, turn off the heat, drain water compartment, and repeat steps g through k. Repeat treatment until color of solution remains pink-red after the 15-minute treatment. When the solution is pink-red, turn off the heat and drain solution from water compartment.
- m. Replace condensate tube and tighten top of sight glass. Wash out water compartment by closing water-drain valve, opening cold-water supply valve, and allowing the water to flow out through the condensate tube. Continue this overflow until the water does not taste sour.
- n. Drain water compartment, replace vacuum relief valve, close water-drain valve, and the urn is ready for use.

*Scale-Removing Compound, Federal Specification P-S-120, FSN 6850-637-6142.

APPENDIX B

Recommended Procedure for the Removal of Hard-Water Scale From Bains-Marie and Steam Tables by Organizational (1st and 2nd echelon) Maintenance Personnel

- a. Close drain valve.
- b. Insert overflow tube in outlet.
- c. Fill with enough water to cover heating coils.
- d. Sprinkle 1/2 to 2 cupfuls of scale remover* into the steam bath or bains-marie while the water is being added.
- e. As soon as the coils are covered, admit steam and heat the solution to a temperature between 160° and 190°F.
- f. Check color of solution and evolution of gas every five minutes. If the color of the solution changes from red to yellow, add more scale remover until the color remains pink-red.
- g. When all the scale has been dissolved, rinse the equipment thoroughly with fresh water.

*Scale-Removing Compound, Federal Specification P-S-120, FSN 6850-637-6142.

APPENDIX C

Recommended Procedure for the Removal of Hard-Water Scale from Dishwashers By Organizational (1st and 2nd echelon) Maintenance Personnel

- a. Drain both wash and rinse tanks.
- b. Close the wash-and-rinse-tank drain valves. Add about 12 gallons of hot water to the tank (or in each tank, of a dual-tank machine.)
- c. Sprinkle approximately one cupful of scale-removing compound* on the scrap trays of both the rinse and wash compartments.
- d. Start recirculation of the solution without the addition of water. Regulate steam valves to maintain a temperature between 160° and 190°F. Check color of solution every 10 minutes. Carbon dioxide is evolved as long as scale and scale remover are present, and the solution will remain red as long as the scale remover is present.
- e. If scale is not completely removed and solution is yellow, sprinkle another cupful of the scale-removing compound on each scrap tray. Continue recirculation. Swab, untouched scaled areas with this solution. Add more remover if required. Scale on the final spray headers may be removed by using a brush and a small amount of remover made into a paste with water.
- f. After the scale is removed, gases cease to form and the color of the solution remains pink-red. Drain solution.
- g. Fill both wash and drain tanks with fresh water. Circulate for 5 minutes. Drain wash water.
- h. Refill tanks and repeat operation in paragraph "g" until wash water does not taste sour.

*Scale-Removing Compound, Federal Specification P-S-120, FSN 6850-637-6142.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Natick Laboratories Natick Massachusetts 01760		2a. REPORT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP	
3. REPORT TITLE METHODS FOR REMOVAL OF HARD-WATER SCALE FROM ARMY KITCHEN EQUIPMENT			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) June 1964 to January 1967 Final Report			
5. AUTHOR(S) (First name, middle initial, last name) Theodore Kapala and George J. Merritt			
6. REPORT DATE March 1967		7a. TOTAL NO. OF PAGES 17	7b. NO. OF REFS 8
8a. CONTRACT OR GRANT NO.		8b. ORIGINATOR'S REPORT NUMBER(S) 67-33-CM	
a. PROJECT NO.		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) C&OM-32	
c.			
d.			
10. DISTRIBUTION STATEMENT Distribution of this document is unlimited. Release to CFSTI is authorized			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY U.S. Army Natick Laboratories Natick Massachusetts 01760	
13. ABSTRACT Hard-water scale is formed in nearly all food-preparing and serving kitchen equipment in which water is heated, and its removal is a major problem to the U. S. Army in hard water areas. As a result of this investigation, methods for the removal of hard-water scale in minutes or hours, depending on the quantity of deposits, were developed using a chemical scale-removing compound available from Government supply agencies. A product containing primarily sulfamic acid, a pH indicator, a corrosion inhibitor and an anticaking agent proved most economical and effective for this purpose. The cause of water hardness, the formation of hard-water scale, the properties of scale removers, and the recommended methods for the prevention and removal of scale from the various types of kitchen equipment are discussed.			

DD FORM 1473

REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

Unclassified

Security Classification

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Evaluation	8,					
Sulfamic acid	9					
Scale-removal compounds	9					
Bains-marie	9					
Coffee makers	9					
Dish washers	9					
Steam tables	9					
Cooking devices	9					
Kitchen equipment and supplies	9,4					
Scale (corrosion)	3					
Hard-water	0					
Armed Forces supplies	4					

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